

1 **Influence on the implementation of biosecurity measures in dairy cattle farms:**
2 **Communication between veterinarians and dairy farmers**

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17 **Abstract**

18 This study was carried out in two regions in Spain (Catalonia and Galicia) through eight focus
19 groups; four for dairy farmers and four for veterinarians. The results showed that dairy farmers
20 and veterinarians attributed responsibility to one another for not following biosecurity
21 practices. The study brings to light contradictions among veterinarians and certain individual
22 veterinary practices that participated in the study, which lead to doubt and confusion on the
23 part of dairy farmers. Distinct perceptions were also identified of the role that government
24 authorities should play in relation both to training and sanctions as a means of improving
25 biosecurity on dairy farms. Additionally, the participants expressed varying opinions as to
26 whether biosecurity measures ought to be made mandatory or remain voluntary. Results from
27 this study highlight the need to promote initiatives through which distinct stakeholders such as
28 veterinarians, government authorities, and dairy farmers can develop consensus-based
29 messages on the implementation of biosecurity practices.

30 **Introduction**

31 Biosecurity is defined as “A set of management and physical measures designed to reduce the
32 risk of introduction, establishment, and spread of animal diseases, infections, or infestations to,
33 from, and within an animal population” (OIE, 2018). Consequently, it is important in
34 understanding how farmers maintain an optimal state of animal health (Satyanarayana et al.,
35 2008). In reality, farmers’ biosecurity practices are inconsistent among distinct groups of
36 farmers, within distinct geographical contexts and, more generally, within the agricultural
37 commodity chain (Maye and Chan, 2020). In particular, the implementation of biosecurity
38 measures in dairy cattle farms is influenced by a diversity of people and contexts present within
39 these, and by a context in which dairy farmers take various risks in their final decisions (Oliveira
40 et al., 2018; Ritter et al., 2017; Cardwell et al., 2016; Lestari et al., 2014; Brennan and Christley,
41 2013; Brennan and Christley, 2012).

42 Veterinarians are the main source of information on animal health and health management for
43 dairy farmers (Moya et al., 2020; Damiaans et al., 2018; Shortall et al., 2017). Consequently,
44 veterinarians have a central role in delivering practical information on how to feasibly carry out
45 biosecurity measures to farmers (Denis-Robichaud et al., 2019; Damiaans et al., 2018; Kuster et
46 al., 2015). In this sense, knowledge and awareness are not usually a limitation for veterinarians
47 in advising farmers (Denis-Robichaud et al., 2020; Pritchard et al., 2015), and farmers use and
48 trust the information provided by veterinarians (Derk et al., 2013). Despite this, the promotion
49 by veterinarians of preventive measures for farmers is limited and could be improved through
50 better communication skills and through collaborative work among veterinarians (Denis-
51 Robichaud et al., 2020; Ruston et al., 2016; Shortall et al., 2016). In fact, poor communication
52 skills can be seen in the lack of agreement between veterinarians and their farmer clients on the
53 discussion of specific biosecurity practices, where a higher proportion of veterinarians and a
54 lower proportion of farmers report having discussed this. Similarly, the usefulness and
55 importance of biosecurity may differ between veterinarians' perception of the perception of
56 their farmer clients and farmers' own perception (Denis-Robichaud et al., 2020). Communication

57 between veterinarians and farmers is therefore of paramount importance, to the extent that
58 poor communication skills on the part of veterinarians can be detrimental to veterinarian-farmer
59 trust and to their working relationships (Svensson et al., 2018).

60 In the farm production system, all stakeholders involved in the production chain must be
61 committed to biosecurity in order to implement efficient biosecurity practices (Siekkinen et al.,
62 2012), although they may have different understandings of biosecurity (Gunn et al., 2008).
63 Hence, dairy farmers and veterinarians should carry out intra- and inter-group work to achieve
64 that these practices are implemented in such a way. While there are some exploratory studies
65 that evaluate collaborative work among dairy farmers in other fields, such as production and
66 finance (Kristensen and Enevoldsen, 2008), there are no such studies on collaborative working
67 among veterinarians.

68 In light of this, the main objective of the present study was to explore and scrutinise the
69 communication dynamics between veterinarians and dairy farmers in relation to biosecurity
70 practices in Spain. We suspect that biosecurity measures are poorly implemented since, on the
71 one hand, dairy farmers do not fully trust their veterinarians and, on the other hand,
72 veterinarians do not properly raise awareness among their dairy farmer clients. In this scenario,
73 the establishment of face-to-face meetings could be a possible solution.

74 **Ethics Statement**

75 This study was approved by the Ethics Committee of the *Universitat Autònoma de Barcelona*
76 (CEEAH 4055), which helped in the design of the Informed Consent for participants. The
77 Informed Consent document was used to explain the objectives of the study and the conditions
78 and guarantees pertaining to all participants. The document indicated that all data were
79 confidential and would be processed anonymously; that no financial benefits were offered for
80 participating; and that all focus-group activity would be recorded by audio or text. Participation
81 in the study was entirely voluntary, and participants could leave the focus group at any time.

82 The Informed Consent document was signed by participants and researchers, and a copy was
83 provided to each of them.

84 **Materials and methods**

85 **Study area:**

86 **Dairy farms:**

87 This research was conducted in Spain in two of its so-called *Autonomous Communities* (semi-
88 independent regions). One area is Galicia—located in the north-west—and the other is
89 Catalonia—located in the north-east. In general, Galician dairy farms are small and family-based
90 compared to the sizeable Catalanian farms owned by large production companies (MAPAMA,
91 2016; De Llano, 1989). Galicia has 55% of all Spanish dairy farms, with an average of 43 cows per
92 farm; Catalonia, in contrast, has 4% of all Spanish farms but with an average of 144 cows per
93 farm (MAPAMA, 2018). Galicia produces 39% of all milk produced in Spain; Catalonia accounts
94 for 10% of national production (MAPA, 2020a).

95 **Types of veterinarians:**

96 Throughout Spain (as elsewhere) there are control programs for regulated diseases that are
97 generally compulsory (e.g., Bovine Tuberculosis) and for non-regulated diseases that are
98 generally voluntary (e.g., Bovine Viral Diarrhoea). In these control programs, farms are brought
99 under the auspices of Health Defence Associations (hereafter HDA; the acronym in Spanish is
100 ADS). HDA are managed directly by farmers and receive financial subsidies from the government
101 to support the activities included in control programs. In this regard, HDA can directly contract
102 veterinarians in implementing such programs. In this article, veterinarians termed animal health
103 veterinarians (hereafter AHV) can also be contracted—in the case of regulated diseases—by
104 public companies who, at the same time, are subcontracted by the government. In Galicia,
105 control programs of non-regulated diseases are conducted by AHV contracted directly by HDA,

106 while the control of regulated diseases is conducted by AHV contracted by public companies to
107 participate in these compulsory eradication programs. In contrast, in Catalonia, AHV
108 participating in the control of regulated diseases are contracted directly by the HDA, and there
109 are no control programs for non-regulated diseases.

110 Veterinarians termed private veterinarians (PV) advise on distinct technical areas relating to
111 herd health management (e.g., clinical/physician, reproduction, milk quality or nutrition).
112 Finally, veterinarians belonging to the official veterinary services are responsible for monitoring
113 farmers and veterinarians, ensuring that they carry out certain compulsory practices; they also
114 control HDA activities. This last group is not included in this study.

115 **Study design:**

116 Qualitative research was conducted using focus groups. This qualitative technique brings
117 together people who have certain characteristics in common, allowing them to share their views
118 and to interact with each other on a specific topic (Rezaeian, 2019; Kitzinger, 1994). We used
119 this technique as: i) we had insufficient information on dairy farmer-veterinarian
120 communication dynamics that involve biosecurity; ii) we wanted to directly ascertain
121 justifications for the opinions held by dairy farmers and veterinarians; iii) it facilitated addressing
122 complex and sensitive issues on a range of communication skills and biosecurity measures
123 among the parties concerned; and iv) we wanted to generate an environment in which both
124 groups (farmers and veterinarians) could set out their problems and needs in relation to
125 biosecurity (Dilshad and Latif, 2013).

126 Eight focus groups were used in this study. Following Guest et al. (2016), who pointed out that
127 90% of discussion topics could be covered by three to six focus groups, four focus groups per
128 strata were used in hopes of reaching data saturation. The strata considered were 'type of
129 stakeholder' (i.e., dairy farmers and veterinarians), and 'geographical area' (i.e., Galicia and
130 Catalonia). Despite this, it is difficult to attain total saturation since there is always the possibility

131 of uncovering new concerns from the data (Hennink et al., 2019). Convenience sampling was
132 used, based on the availability of those wishing to participate in this study (Etikan et al., 2015).
133 Dairy farmers and veterinarians were contacted through the professional network of this study's
134 researchers. As a result, groups of 14 farmers and 8 veterinarians were created. A higher number
135 of farmers was initially planned, as it was assumed that the probability of not attending focus
136 group meetings was higher among this sector. Figure 1 and Table 1 describe the characteristics
137 of the dairy farmers and veterinarians attending each of the focus groups.

138 Focus groups were conducted from 14 March 2019 to 9 September 2019 in both regions.
139 Sessions were conducted face-to-face, recorded on audio tape, and lasted between 60-90
140 minutes. The focus-group recordings were then reviewed and transcribed by the first author of
141 this article for data analysis. In the transcripts, statements were labelled with as "F" for dairy
142 farmers or "V" for veterinarians, followed by "G" for Galicia or "C" for Catalonia; a number (i.e.,
143 1 or 2) was also used for group differentiation (e.g., FG1 refers to a focus group of dairy farmers
144 from Galicia). The original statements were translated and verified by two native speakers and
145 a language service of the Universitat Autònoma de Barcelona, who verified that the meaning of
146 the statements was maintained. Statements in the original language are given in the appendix.

147 Data were analysed using critical discourse analysis through ATLAS.ti.8.4.18 (ATLAS.ti, 2019).
148 This analysis was used as it facilitates far greater understanding of meaning and helps to
149 comprehend complex phenomena, as described by Fairclough (1992). In this way, the ideas
150 expressed by farmers and veterinarians were more comprehensively scrutinised, thereby
151 providing a greater elucidation of biosecurity practices (Ponton and Larina, 2017; Ponton and
152 Larina, 2016; Hodges et al., 2008; Van Dijk, 1998).

153 In addition, critical discourse analysis takes a social and political approach (Van Dijk, 2001). This
154 analysis therefore includes a relationship between discourse and social processes and
155 structures, in which discourse influences social processes and structures, and vice versa

156 (Hidalgo, 2011; Fairclough, 1992); in this case, this relationship was that shown by the intra- and
157 inter-group discourse and social processes and structures of dairy farmers and veterinarians.
158 The analysis was based on the various statements made directly by participants. However, these
159 statements were associated with the four main strata (i.e., FG, FC, VG and VC) and not with an
160 individual speaker (Duggleby, 2005).

161 **Results**

162 The results of this study were organised into two main themes: veterinarians (sub-themes:
163 'contradictions' and 'face-to-face meetings') and government authorities (sub-themes: 'roles',
164 'mandatory biosecurity measures', and 'basic biosecurity measures').

165 **Perceived veterinarian contradictions: Who is right?**

166 Farmers emphasised that advice in relation to biosecurity could be divergent among
167 veterinarians. This divergence, in the opinions both of farmers and veterinarians, may be
168 influenced by the veterinarians' training and competence in biosecurity, the availability of time
169 spent on farms, knowledge of the farm, and each veterinarian's intrinsic characteristics (i.e.,
170 personality). Consequently, veterinarians may have distinct perceptions of biosecurity, and
171 distinct approaches to it, resulting in various contradictions.

172 Some contradictions were characterised by a discourse that, on the one hand, promotes the
173 implementation of biosecurity measures among farmers by veterinarians, yet, on the other,
174 were not borne out by certain veterinarians' actual practices, which were not in accordance with
175 such discourse. In this respect, some farmers challenged practices that increased the risk of
176 introducing infectious diseases onto their farms; specifically, veterinarians entering their clients'
177 farms with dirty boots:

178 *(1)FG1: "(...) The best measure is for vets to bring clean boots, properly clean. Nothing's*
179 *worse than them arriving with manure on their boots, putting on disposable plastic*

180 *overshoes and then dragging their feet along; when they go from here to there the plastic*
181 *gets broken and so the contact is obviously the same as not having any protection at all.*
182 *I think that the vets should see that for themselves; farmers shouldn't have to ask for*
183 *this.*

184 *And on top of that, they don't like it when you tell them (...)"*

185 Similarly, on this same topic, certain farmers mentioned the excuses that some veterinarians
186 gave them, such as not wanting to wear disposable plastic overshoes because they could slip:

187 *(2)FG1: "(...) For one thing, for some vets, it's an effort just to put on disposable plastic*
188 *overshoes.*

189 *We have to insist on this, if necessary, even with people who come here to teach us. With*
190 *vets, we have to be very insistent about them putting on disposable plastic overshoes;*
191 *they say that they slip if they wear them. They should be coming here to help us have a*
192 *clean farm, but instead they end up making it dirty.*

193 *I think that AHV contracted by public companies excuse themselves by always pouring*
194 *liquid over their boots before starting.*

195 *On the other hand, clinical vets do come with boots, they come in and when they leave,*
196 *they wash them, but without disinfecting (...)"*

197 Similarly, farmers did not understand why veterinary professionals with the same training and
198 competences (i.e., the same type of veterinarian) could provide different or even contradictory
199 advice on standards of on-farm biosecurity practices. In particular, there were distinctive
200 differences among AHV involved in an HDA in providing on-farm biosecurity advice for farmers.
201 In this situation, certain farmers were confused by the fact that some AHV involved in an HDA
202 farm visit did not follow the same biosecurity practices. Such divergence leads farmers to
203 distrust and question veterinarians' awareness of the preparations required for reducing the risk

204 of disease. Some farmers expressed surprised that recently graduated veterinarians could make
205 these mistakes, as biosecurity is an important subject that should be covered in training:

206 *(3)FG1: “(...) I once had an AHV contracted by the HDA who got here with worn-out boots,
207 it was impossible for him to clean them. And he said: ‘If you want, I can put bags over
208 my boots’; but he didn’t have any disposable plastic overshoes in the car either. He was
209 here for a very short time. He was a young vet who’d only recently finished his degree,
210 which is even more serious (...)”*

211 In a similar mode, certain farmers did not understand why some AHV gave them advice on
212 biosecurity, while others did not:

213 *(4)FG1: “(...) In my case, the vet doesn’t advise me about biosecurity.*

214 *In some cases, the AHV contracted by the HDA explains how you should do things. Or
215 they ask you ‘if you have a problem, how are you going to resolve it?’ But they don’t
216 explain much to you anyway (...)”*

217 During the focus groups, the participating veterinarians had divided views on a number of
218 biosecurity measures, such as whether farmers should install disinfection arches to clean
219 vehicles entering the farms. In this respect, some clinical or reproduction veterinarians pointed
220 out that farms should have disinfection arches for vehicles; in contrast to this, the HDA
221 veterinarians pointed out that it was unrealistic, and it would be more effective if only essential
222 vehicles entered the farms via specific roads.

223 In light of the contradictory views expressed by veterinarians on the instalment of disinfection
224 arches, farmers began questioning the ability and trustworthiness of their own veterinarians,
225 since differing types of veterinarians gave conflicting advice, as the following comments show:

226 *(5)FG1: “(...) The thing is that the criteria the vets have sometimes don’t match, and then
227 you get confused. The reproduction vets come along, and they tell you one thing; later,*

228 *the clinical vets come by, and they tell you another thing. And sometimes their criteria*
229 *just doesn't match up. So you get more confused about what you should do.*

230 *That's especially the case when you get conflicting advice from AHV contracted by the*
231 *HDA.*

232 *And there are things that you really need to think about, about what you are going to*
233 *do, because you're not very sure and they haven't guided you to anything specific. It*
234 *makes you wonder (...)"*

235 These contradictions were also perceived by veterinarians:

236 *(6)VC1: "(...) Depending on the experience of an individual, one thing will be*
237 *recommended for one farm and something different will be recommended for another.*
238 *And if the individual lacks the ability to demonstrate which [criteria] is actually better, it*
239 *can lead to this clash (...)"*

240 However, farmers also understood that this could happen due to the differing characteristics
241 and competencies of distinct types of veterinarians. This did not necessarily mean that advice
242 from one veterinarian was considered more valid and better than that given by another, simply
243 that the approach suggested was different. In fact, veterinarians pointed out that divergent
244 approaches might be owing to different specialisations in veterinary science and to the relative
245 degree of importance ascribed to biosecurity practices:

246 *(7)VG1: "(...) I think that we all have the same essential training, in spite of individual*
247 *specialisation. We leave the faculty knowing all about biosecurity; but what happens is*
248 *that, afterwards, each person applies this knowledge in their area (or doesn't apply it, as*
249 *the case may be); or else it's easier to apply it for one person but far more difficult for*
250 *another, it is very different (...)"*

251 **Face-to-face veterinarian meetings: Do the meetings actually take place?**

252 Veterinarians acknowledged the diversity and the specialisation of veterinarians visiting farms,
253 and the need to organise face-to-face meetings among themselves:

254 *(8)VG1: “(...) There are different technicians working on the same farm. Milk quality,*
255 *clinical, reproduction, nutrition, or AHV contracted by the HDA. If they do come [to the*
256 *farm], what does each one say?”*

257 *What we need to do here, regardless of whether we’re from the same working team or*
258 *not, when there is a problem on a farm and it affects everybody, what we need to do is*
259 *meet up and talk (...)”*

260 *(9)VG2: “(...) So they tell me: ‘I’ve got problems with Bovine Viral Diarrhoea’. So, you talk*
261 *to the AHV contracted by the HDA, that’s their area, and you get involved in the HDA*
262 *program to control it. And it’s like what I said: ‘I don’t have the time to come here every*
263 *time a calf’s born, I don’t have time and it’s not my area of specialisation’. I think that*
264 *specialisation is leading us towards this, to look for collaboration.*

265 *We need to meet up more (...)”*

266 Veterinarians commented that reasons for face-to-face meetings among the different
267 veterinarians visiting a farm were few, but included moments when they work together (i.e., on
268 the same team) or in exceptional situations such as an outbreak of an exotic disease. Some
269 veterinarians believed that such meetings were necessary in order to resolve problems for the
270 benefit of farmers. However, veterinarians were also aware that their discrepancies should be
271 resolved among themselves only, keeping farmers out of such discussion to avoid generating
272 the distrust commented on above. These veterinarians therefore suggested that a problem
273 should be approached collectively, among veterinarians only, in order to give unanimous advice
274 to farmers.

275 According to certain veterinarians, farmers supported the idea of meetings exclusively among
276 veterinarians. At all events, although veterinarians showed their willingness to participate, they
277 also pointed out that it should be farmers who encouraged these meetings, even though this
278 was actually rather complex to achieve:

279 *(10)VG2: "(...) In short, there is no collaboration. The only person linking everyone*
280 *together is the farmer, and in theory they should be deciding these things because*
281 *they're the ones paying everybody. But the problem is that farmers are not usually*
282 *qualified, they're not seen as leaders to coordinate a team of veterinarians.*

283 *The issue is that, if farms function as companies, who can direct them? I think that there*
284 *are farmers who are perfectly well trained to do this. But there are others who simply*
285 *aren't. I don't know what kind of "figure" we need to run things in such cases. Or maybe*
286 *those who aren't specifically trained are just doomed to disappear.*

287 *As regards that "figure", I really don't know who it should be. I think it should be a farmer,*
288 *but a farmer probably needs technical counselling in order to identify problems. The*
289 *concept of "having problems" is very subjective; every farmer understands them*
290 *differently (...)"*

291 Veterinarians therefore believed that some farmers did not have the requisite skills (i.e.,
292 leadership and knowledge) to manage face-to-face meetings among veterinarians. Additionally,
293 the perception of problems that farmers may face could vary, and may need technical
294 counselling in order to be appreciated.

295 The veterinarians also stressed that farms need to function as competent companies or else
296 eventually disappear. This is particularly the case with the very small farms in Galicia, which are
297 characterised by a low level of professionalism, a factor that might also limit the implementation
298 of biosecurity measures.

299 Some veterinarians drew attention to the current absence of face-to-face meetings among
300 colleagues as problematic, since these are a framework within which to gain familiarity with
301 distinct veterinary disciplines, or as a means of carrying out direct consultation with such
302 colleagues to resolve certain technical problems common, which might also include biosecurity
303 measures. However, not all veterinarians favoured such a framework. In this regard, they
304 highlighted the fact that the distinct questions raised by farmers should be transferred to the
305 relevant veterinarians only, and discarded the option of approaching disciplines distinct from
306 their own. In this sense, veterinarians did not seek to invalidate any analyses made by others or
307 pass on responsibilities to others. Nevertheless, on some occasions they appeared to disregard
308 certain problems:

309 *(11)VG2: “(...) There’s very rarely any direct conflict. I don’t find myself in situations*
310 *where I need to say to a farmer: ‘You decide: either listen to me, and give the animal a*
311 *branded vaccine [the veterinarian understands this as a biosecurity measure], or listen*
312 *to them, and do something else’. That doesn’t really happen very often; but what does*
313 *happen is that we keep knocking the ball backwards and forwards into each other’s court*
314 *(...)”*

315 In agreement with these remarks, certain veterinarians stressed that clashes among
316 veterinarians were not common, nor were attempts to force farmers into making the final
317 decision on these matters.

318 **The roles of government authorities: Reality and expectation**

319 Farmers mentioned that government authorities (hereafter simply ‘the authorities’) have
320 primarily a sanctioning role, although they commented that this role varied among regions. The
321 possibility of being sanctioned is the reason that farmers have a defensive attitude towards (or
322 plainly distrust) official veterinarians. However, farmers also observed that, in those regions in
323 which the primary sector is more important, farmers received greater support:

324 (12)FC2: “(...) When the authorities come to the farm, 99% of the time it’s to fine us, they
325 don’t come to find out what we’re doing. In other parts of Spain, things are different, the
326 authorities are at the same level as the farm because the primary sector is really
327 important there. But here, when an outsider [official veterinarian] comes to your farm,
328 you have to keep an eye out for things (...)”

329 In spite of the previous statement, one farmer mentioned that, on one occasion, farmers and
330 official veterinarians had convivially enjoyed a meal together, and commented that this situation
331 of “friendship” between both sectors should be normalised.

332 Farmers disagree with biosecurity measures that, in their opinion, do not make sense (such as
333 visitor registers, for example). Additionally, farmers added that their attitudes towards certain
334 measures are influenced by their views of official veterinarians (i.e., of the authorities as
335 represented by that veterinarian) who, they feel, do not have enough knowledge about their
336 farms. They observed that official veterinarians should try to determine the reality of their
337 farms, and understand more fully how distinct farm activities are carried out. Despite this, both
338 farmers and veterinarians recognised the important role of the authorities, which need to
339 guarantee correct operational functionality, as farms deliver products for human consumption.
340 Farmers and veterinarians also agreed that the authorities should play a more active
341 advisory/training role and not merely that of sanction-giver:

342 (13)FC2: “(...) They [official veterinarians] should help us; what they should do is
343 collaborate, provide a little guidance for us. They come with the excuse that, as they’re
344 regulated by the EU, they have to comply with these regulations. It’s not that they want
345 to, they say, it’s because they’re obliged to. That’s one part of the story. The other part
346 is what we say: ‘A little bit of collaboration, help or advice would be fine, if it wasn’t that
347 they always come to fine us’ (...)”

348 *(14)VG1: “(...) The authorities, in my view, minimally ensure that everything works, ‘more*
349 *or less’. Food for human consumption is being produced, and some supervision helps*
350 *ensure that the whole sector works correctly. And this calls for the presence of an*
351 *important arbitrator.*

352 *But I do believe that the authorities should be more involved in training. I think it should*
353 *do more in this ambit, and not always focus on sanctioning. Farmers and even*
354 *veterinarians should be trained.*

355 *I think the authorities should have a double role. They need to must energise resources,*
356 *important resources for training and for implementation, to establish animal health*
357 *programs – this seems fundamental to me. And then there’s the need for control, I think*
358 *that control is necessary: thinking of the authorities as a friend just doesn’t work (...)”*

359 The authorities should therefore have a regulatory (supervisory) role that both advises and
360 sanctions concurrently. Specifically, as regards training, the authorities could expand the
361 incorporation of biosecurity measures based not only on official health programs (i.e., with
362 regulated diseases) but also based on other infectious diseases, as is the case for example in
363 Galicia with HDA programs (i.e., with non-regulated diseases). Consequently, animal health
364 programs could be generated to favour both the productive sector and the end consumer. In
365 the same way, according to farmers, the authorities should ensure that all farms follow certain
366 basic biosecurity measures, thereby avoiding heterogeneous risk perceptions. They could
367 therefore anticipate problems, instead of relying on measures implemented by the farmers
368 themselves.

369 Finally, some farmers pointed out that the authorities should not merely be concerned with
370 what happens within their own farms, but should also monitor what happens outside their farm
371 premises. In this sense, it has been mentioned that there should be measures to control wild
372 animals, which cause numerous problems. These farmers observed that the authorities should

373 be responsible for these problems and their consequences, as farmers can take responsibility
374 only for what happens on their own farms, and at all events also have a range of other problems
375 to solve. Dairy farmers, additionally, perceived that other animal production systems (e.g., swine
376 and poultry) are less affected by wild animals in comparison to the dairy sector, since other
377 sectors have very little direct contact with wild animals:

378 *(15)FC1: "(...) Measures to control the population of wildlife in the country.*

379 *We are affected by wild animals. It is out of the authorities' control, and the wild-animal*
380 *population is getting more and more serious, we're really suffering from this problem.*

381 *It's 100% the authorities' responsibility.*

382 *We can be responsible for the premises inside the farm, but not for the environment*
383 *outside; the authorities should be responsible for the environment surrounding the farm.*

384 *It is different for dairy cattle than for poultry or swine.*

385 *Apart from wildlife, we have other problems. There are areas close to farm animals with*
386 *lots of different problems, not just with wild animals (...)"*

387 **Mandatory biosecurity measures**

388 There was some discrepancy among veterinarians regarding the mandatory nature of
389 biosecurity measures (e.g., control of cattle movements in an HDA), based on the tactic of
390 'apprehension' (i.e., a tactic that depends on the reluctance to receive sanctions), and on
391 strategies to increase farmers' biosecurity awareness. Some veterinarians pointed out that
392 mandatory measures from the authorities increase workload, since farmers have to implement
393 them in order to avoid being penalised. However, penalties can also foster the implementation
394 of measures on farms, as was the case with the control of antibiotics in milk, which led to a
395 favourable change. According to some veterinarians, establishing mandatory biosecurity
396 measures will lead farmers to implement them more effectively as they will be reluctant to

397 receive penalties and will want to avoid breaking the law. Conversely, there were veterinarians
398 and farmers who highlighted the redundancy of making biosecurity measures compulsory.
399 These people proposed, instead, constructive action such as subsidising certain basic measures
400 or providing positive incentives, such as with controls on milk quality, which could be
401 requirements for the market access of final products:

402 *(16)VG2: "(...) For a dairy company to be able to export to third-world countries, it has*
403 *to carry out some measures for certain diseases. Milk quality in the end was attained by*
404 *penalisation within the industry (...)"*

405 *(17)FG2: "(...) To obtain points granting access to a subsidy, you have to do that. It may*
406 *not actually be obligatory, but if you want access to a subsidy, the authorities give you*
407 *points for having that (...)"*

408 Farmers added that obligations or incentives for biosecurity measures should be given for those
409 measures that are in fact useful to them. On the other hand, some veterinarians said that
410 biosecurity measures should not be mandatory; instead, farmers should be aware of the
411 importance of these measures for farms and for final products. As regards this latter point,
412 certain veterinarians also added that the authorities should establish a series of measures that
413 could be accompanied by an explanation and objective so that biosecurity measures would
414 make better sense. Additionally, the positive effectiveness and impact of these measures should
415 be demonstrated through studies so that farmers can understand why they need to implement
416 them. Crucially, farmers noted that mandatory measures should consider the context of each
417 particular farm (e.g., infrastructure and environment).

418 Finally, several farmers pointed out that preventative measures to reduce risks of introducing
419 certain pathogens into farms should be voluntary, since this relates to their farms only, and does
420 not represent a risk for third parties. In addition, these farmers considered themselves to have
421 already implemented several measures voluntarily. Nonetheless, other farmers mentioned that

422 measures capable of reducing the risk of releasing and spreading certain pathogens from their
423 farms should be mandatory, but that they require financial support from the authorities:

424 *(18)FC1: "(...) I think it shouldn't be obligatory, because if there is a disease it's you who*
425 *allows it to enter into your own farm.*

426 *I think there should be both obligatory and voluntary things. I don't personally agree with*
427 *fencing off all farms or having a disinfection arch. If that's obligatory one day, then the*
428 *authorities should help subsidise it.*

429 *A lot of measures are already being implemented voluntarily.*

430 *Obligatory, in the first place, only whatever might be harmful from your farm to another,*
431 *but if it's only harmful to you, it's your responsibility; that should be voluntary (...)"*

432 **Basic biosecurity measures**

433 Some farmers also highlighted the importance of not only considering external routes of
434 introduction, but also possible spread within farms due to farm workers or to feeding
435 management. In this regard, certain veterinarians also indicated that solutions need to be
436 different according to the situation (i.e., prevention and emergency). As regards preventative
437 measures, these veterinarians emphasised the importance of initiating approaches with a
438 general on-farm diagnosis, and with a personalised risk analysis, to establish basic biosecurity
439 measures in the short, medium, and long-term.

440 In contrast to this, according to veterinarians who did not hold these views, basic measures
441 should mainly be directed towards those infectious diseases that could affect animal health, as
442 well as having a financial and commercial impact on farms. In this vein, some veterinarians also
443 pointed out that non-zoonotic diseases should be taken into account by the authorities through
444 official animal health programs, noting that they might eventually consider that a risk could
445 become zoonotic.

446 Veterinarians also mentioned that other production systems (e.g., poultry or swine) are stricter
447 than dairy farms. Such systems have, for example, mandatory basic measures relating
448 exclusively to clothing and the condition of machinery, as well as isolated collection sites for
449 dead animals.

450 Some farmers were aware that there is broad scope for improvement in implementing
451 biosecurity measures, but they did not completely agree on establishing mandatory basic
452 measures as, in their view, this was a question of common sense. However, other farmers
453 disagreed, since ‘common sense’ tends to vary by individual. In light of this, these farmers
454 pointed out that the authorities should indeed intervene through official control programs, with
455 which they may or may not agree:

456 *(19)FC2: “(...) I think that there has to be some common sense, doing things right. It’s a*
457 *problem that needs a solution, a little common sense and doing things as they should be*
458 *done. Then there’d be no problems, not even for things like fences.*

459 *Common sense is very variable; for one person, one measure might be normal and for*
460 *another it could be complete nonsense.*

461 *It’s all very complicated; I think that the authorities should have basic standards to apply,*
462 *which we might like or might not (...)”*

463 In addition to this, some farmers cautioned that basic measures—if they became mandatory—
464 should be implemented gradually. Nevertheless, veterinarians argued that if biosecurity
465 measures are implemented, controlling and monitoring such implementation would be
466 complicated, and that this would hamper the implementation of these measures by the sector
467 as a whole. To this observation, farmers added the importance of understanding the
468 effectiveness of biosecurity measures if they became mandatory. For example, certain farmers
469 observed that a disinfection point could be placed at the entrance to a farm, but if it was located
470 in a separate place and nobody used it, it would not be effective. A similar situation could occur

471 with other measures, such as perimeter fences and farm registers of entries and exits, the
472 effectiveness of which was questioned:

473 *(20)FC2: "(...) The measures have to be really effective. If the authorities say that you*
474 *have to wear a disinfection backpack, I can't see that working because the backpack'll*
475 *never be touched and that'll be the end of it. But, if they force you to have a place for*
476 *trucks with disinfectant, that'd be more effective, I think.*

477 *It is the same as closing your perimeter with fences: you can't close in all your hectares,*
478 *it's just not feasible (...)"*

479 Certain veterinarians once again highlighted the role of the veterinarian, who is a fundamental
480 and decisive figure of reference in the implementation of biosecurity measures, with some
481 veterinarians pointing out the necessity of their support for ensuring implementation of basic
482 measures. Similarly, other veterinarians commented on the importance of cohesion among all
483 sectors, beginning with shared objectives, and on the need for collaboration among distinct
484 veterinarians. However, following on from these basic measures, other veterinarians pointed
485 out that when certain fundamental levels are attained and favourable results are achieved by
486 farms, new objectives could then be created.

487 **Discussion**

488 With respect to the dynamics of communication between dairy farmers and veterinarians,
489 contradictions among veterinarians were particularly evident. The contradictions pointed out in
490 this study among veterinarians seem to derive from a lack of specific regulations throughout
491 Spain. Animal Health Law (Regulation (EU) 2016/429) establishes biosecurity as a requirement
492 for managing animal health in an efficient way. Currently in Spain there are no compulsory
493 biosecurity measures for implementation on dairy cattle farms; however, there are several
494 good-practice guidelines that include biosecurity recommendations (INLAC, 2007).
495 Contradictions on this matter may be due to interest, time availability, knowledge of farms, and

496 the personal characteristics of a veterinarian (i.e., there are elements, such as interpersonal,
497 management, decision-making, or problem-solving skills affecting biosecurity advice, and which
498 are mainly related to individual experience). Naturally, this is also the case with any other
499 veterinarian, such as those AHV involved in an HDA, for example, who should theoretically have
500 common and substantiated criteria for giving advice on biosecurity measures.

501 Veterinarians may be responsible for biosecurity measures that have not been correctly
502 conveyed to dairy farmers, since not only do they need adequate knowledge about biosecurity
503 but also be able to transmit and promote this by raising general awareness and by means of
504 distinct training. Through training sessions, the implementation of biosecurity measures should
505 also be directly related to the viability of such measures, which in turn might indirectly depend
506 on the veterinarian. In this regard, veterinarians should primarily consider the needs, priorities,
507 motivations, and objectives of dairy farmers, in conjunction with their perception of the
508 effectiveness of the measures being promoted (Svensson et al., 2019). In fact, Visschers et al.
509 (2016) and Kuster et al. (2015) point out that veterinarians usually recommend preventive
510 measures that they believe are feasible and effective to carry out. In this sense, communication
511 is crucially relevant in the professional relationship between veterinarians and dairy farmers.
512 Therefore, although farmers are generally satisfied with their interactions with their
513 veterinarians, there is still room for improvement of these interactions (DeGroot et al., 2021).

514 There may be a wide range of factors that can affect communication between dairy farmers and
515 veterinarians. In this study, we observed that there are veterinarians who are not greatly
516 predisposed to recommending biosecurity measures to dairy farmers, which in turn can
517 influence dairy farmers' interest. This lack of predisposition, together with seemingly
518 contradictory advice given by veterinarians, may then result in dairy farmers not implementing
519 biosecurity measures. In this respect, our study is in agreement with those conducted by Ruston
520 et al. (2016), or Hall and Wapenaar (2012), who pointed out that veterinarians have become

521 'partial prevention' advisors, since there seems to be, in general, little effort given to promotion,
522 although this differs by geographical area and is affected by complex bureaucratic dynamics. In
523 addition to having effective communication skills (e.g., the ability to effectively transmit
524 knowledge), veterinarians must therefore also be proactive advisors and provide consensus
525 messages that are both consistent and linked to continuous monitoring and evaluation (Oliveira
526 et al., 2018; Jansen and Lam, 2012). In other words, veterinarians should draw on their own
527 experience and re-appropriate this to consolidate the information that they provide, thereby
528 improving their communication of 'preventative measures' (Ruston et al., 2016). Consequently,
529 not only are communication skills important; so too are the time and method of communication
530 (Hall and Wapenaar, 2012). On the other hand, due to the characteristics of the different
531 veterinarians, and the different ways in which they are recruited and financed (e.g., through a
532 cooperative or privately), it might be interesting to explore in future studies whether this might
533 also have an impact on disagreements among veterinarians. In addition, it could be elucidated
534 who might have a position to demand a unification and consensus of their messages, as there
535 are currently no elements that motivate them to work together to convey such messages.

536 Regarding to the specialisation that veterinarians may have, there is a possibility that they may
537 recommend biosecurity measures based on such specialisation, mainly considering elements of
538 plausibility on the part of their farmer clients. In this sense, these veterinarians could disregard
539 the limited availability of scientific evidence supporting these measures and have to weigh,
540 prioritise and select some of them according to their own criteria. This could not only deepen
541 disagreements among them, but also deliver different recommendations between farms.
542 However, this situation can be favourable as long as the farmer is aware of this fact and all their
543 veterinarians unify these criteria on their farm, although they may vary between farms according
544 to their particular elements. Despite the above, there may also be difficulties for veterinarians
545 to address certain biosecurity practices with their farmer clients due to their lack of interest,
546 receptivity, opportunity and time, or lack of biosecurity issues and priorities, among others,

547 which may also lead to the delivery of different recommendations between farms (Denis-
548 Robichaud et al., 2020).

549 In relation to collaboration networks between dairy farmers and veterinarians, although it has
550 been established that such networks may be of interest to dairy farmers, even when they are
551 difficult to find (Hovi, 2005), the same cannot be said for collaboration networks among
552 veterinarian which have been completely neglected. We observed that veterinarian
553 collaboration networks tend mainly to be limited to certain types of veterinarians who,
554 nevertheless, may have discrepant views, partly on account of the infrequency of their face-to-
555 face meetings and discussions. As a result, they have greater difficulty in providing a consensus
556 message. In this way, orchestrating such meetings among veterinarians can strengthen
557 veterinarian collaboration networks in favour of dairy farmers. In keeping with this, researchers
558 such as Ruston et al. (2016) have identified the need for veterinarians to work collaboratively
559 rather than competitively among themselves. Notwithstanding this, it is still necessary to
560 address the reasons for this general lack of collaboration, which may not necessarily depend as
561 much on veterinarians as on the context in which they work. Veterinarian competition is
562 reinforced by the diversity and individualism of veterinarians, which may be positive and
563 necessary, but which may also result in inconsistencies (Shortall et al., 2016), meaning that
564 competition amongst a wide range of different types of veterinarians is not useful for dairy
565 farmers.

566 Returning to the issue of face-to-face meetings among veterinarians, it is a significant finding
567 that, although veterinarians indicated that it was the farmers who should demand more
568 collaboration from their veterinarians, this latter group also indicted that farmers are not or
569 would not be able to do this because of inadequate managerial skills. In this sense, a farm can
570 be conceived of as a business in which the businessperson (i.e., farmers) has absolute power
571 over their own decisions. However, there are also subcontracted businesses that condition

572 business through their activities and, therefore, the businessperson often has little power over
573 their decisions. Hence, if a comparison is to be made, it should be noted that veterinarians act
574 as a subcontracted business, over which the farmers have little decision-making power. At all
575 events, and regardless of the farmer's skills, there may be structural elements contributing to
576 this situation, such as veterinarians' organisational schedules (e.g., working times and work
577 rhythms) and the schedules of other stakeholders in the productive sector. Last and by no means
578 least, veterinarians may inadvertently or even consciously transfer the tasks involved in creating
579 durable collaborative networks onto farmers, rather than assuming part of this themselves, as
580 with the example of organising meetings.

581 Therefore, an intra-group collaboration is essential for other members of the group—in this case,
582 veterinarians. Once these issues have been resolved, far more progress could be made in making
583 inter-group decisions, such as those between dairy farmers and veterinarians, to establish
584 mutual objectives (Atkinson, 2010). In this regard, Sayers et al. (2014) also commented that dairy
585 farmers and veterinarians are not regularly in contact, which in turn perpetuates the absence
586 and inconsistency of standardised information given by veterinarians. Instead of such a
587 situation, communication gaps could be overcome by a more effective integration of both
588 groups, regardless of whether dairy farmers and veterinarians have different biosecurity
589 frameworks and distinct perceptions of the problems involved (Shortall et al., 2016). The
590 network of groups should be flexible enough to incorporate other groups subsequently
591 approached, such as milk buyers, who are important agents of the dairy sector in the
592 implementation of biosecurity measures (Richens et al., 2018). Thus, the literature underlines
593 shared decision-making as a crucial element in the development of collaborative work (Wright
594 et al., 2018). In this regard, our study is in accordance with others regarding the communication
595 and exchange of knowledge throughout the entire dairy-sector chain, such as that between dairy
596 farmers and the authorities or consumers (or, as in this current study, between dairy farmers
597 and veterinarians) for the sake of generating collaborative networks (Young et al., 2010).

598 Consequently, although this research contemplated an approximating of the hierarchical
599 relationships between farmers and veterinarians within the dairy sector, it is necessary for
600 future research to analyse other agents within the hierarchical structures of this sector, since
601 the relationships between farmers and veterinarians may also possibly be conditioned by such
602 agents (e.g., milk buyers).

603 Mandatory biosecurity measures are a complex issue as regards dairy farmers and the
604 authorities. The mandatory status of biosecurity measures currently receives increasingly
605 significant attention; this is the case, for example, with the recent approval of the Infectious
606 Bovine Rhinotracheitis program in Spain (Royal Decree 554/2019), an issue of interest because
607 of the pressures exerted on dairy farmers involved in HDA programs. In this sense, it is
608 interesting that farmers insist on maintaining their autonomy over the management of their
609 farms (i.e., less intervention by the authorities), through the justification that, even if they
610 assume animal-health risks, these will not harm third parties—a fact that might be incongruous.
611 Nevertheless, it is interesting that farmers indicate that the authorities should be co-responsible
612 if biosecurity measures become mandatory, eventually assuming part of their cost. Farmers
613 therefore distinguish between two levels of reality, one that is of a productive-economic
614 character; the other of a preventive-health character. What is evident from the farmers’
615 statements recorded in this study is their perception of being trapped between these two levels
616 of reality. In light of this, an analysis of the coincidence between the farmers’ way of viewing
617 these matters, on the one hand, and the productive-economic and preventive-health levels, on
618 the other, should be the subject of future studies.

619 Diverse opinions by dairy farmers were recorded here as regards the authorities, some of them
620 indicating that these mainly played a sanctioning role. This partly coincides with the scenario
621 described by Oliveira et al. (2018), who found that penalties and incentives were essential for
622 ensuring adequate biosecurity practices. Similarly, there was agreement regarding incentives

623 provided by the authorities in other European countries, although in distinct ambits. For
624 example, the New Zealand authorities have generated initiatives to implement a green
625 infrastructure for dairy farmers who meet the regulatory framework. However, the dairy sector
626 and its farmers lacked sufficient motivation to carry out this implementation without the
627 incentive provided by complementary payments from the authorities (McWilliam and Balzarova,
628 2017).

629 In general terms, then, it may be stated that dairy farmers can be positively influenced by
630 veterinarians, and negatively by the authorities, as Brennan et al. (2016) pointed out. Similarly,
631 according to Broughan et al. (2016) dairy farmers did not believe that veterinarians working for
632 the authorities could help them, possibly because of the distrust felt by farmers regarding these
633 authorities (Christley et al., 2011; Enticott, 2008). Again, future studies could carry out an in-
634 depth analysis of the levels of trust existing among the distinct agents involved within the dairy
635 sector, as well as those factors that can increase or reduce such trust, since in a matter of risk
636 management, trust-engendering processes are key. Additionally, communication processes are
637 also essential to levels of trust. Such processes, besides supporting collective action, need to
638 reframe various messages and deliver them from a neutral source (Heffernan et al., 2008).
639 Additionally, there need to be both mandatory and voluntary biosecurity measures, an issue
640 that could improve dairy farmers' perception of the authorities, provided that the authorities
641 take these farmer's participation into account in their policies. It should not be forgotten that
642 changes on dairy farms could be achieved through more active participation of all agents
643 involved (Lahuerta-Marin et al., 2018).

644 **Conclusion**

645 Dairy farmers' understandings of biosecurity practices are shaped by veterinarians. While dairy
646 farmers and veterinarians attribute responsibility to one other for not applying biosecurity
647 measures, the responsibility for carrying out such practices lies with both groups (MAPA, 2020a;

648 Higgins et al. 2016; Donaldson 2013; Gunn et al., 2008). The development and establishment of
649 face-to-face meetings in a participatory manner that involves dairy farmers and veterinarians,
650 both intra- and inter-group, would be beneficial to biosecurity improvement. Perceptions of the
651 authorities by dairy farmers and veterinarians, as well as of the biosecurity measures that may
652 pertain to those authorities, are findings that merit further attention and in-depth study to gain
653 fuller insight into those perceptions and also into the authorities' predisposition towards those
654 under its administration. This article therefore hopes to be a starting point in generating
655 common parameters and unified efforts aimed at developing initiatives for the dairy sector.

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